



Making Erasmus MC Shiny

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- 3) UK Health Security Agency, DHSC.
- 4) BresMed Health Solutions, Sheffield

Before we start ...

Disclaimer:

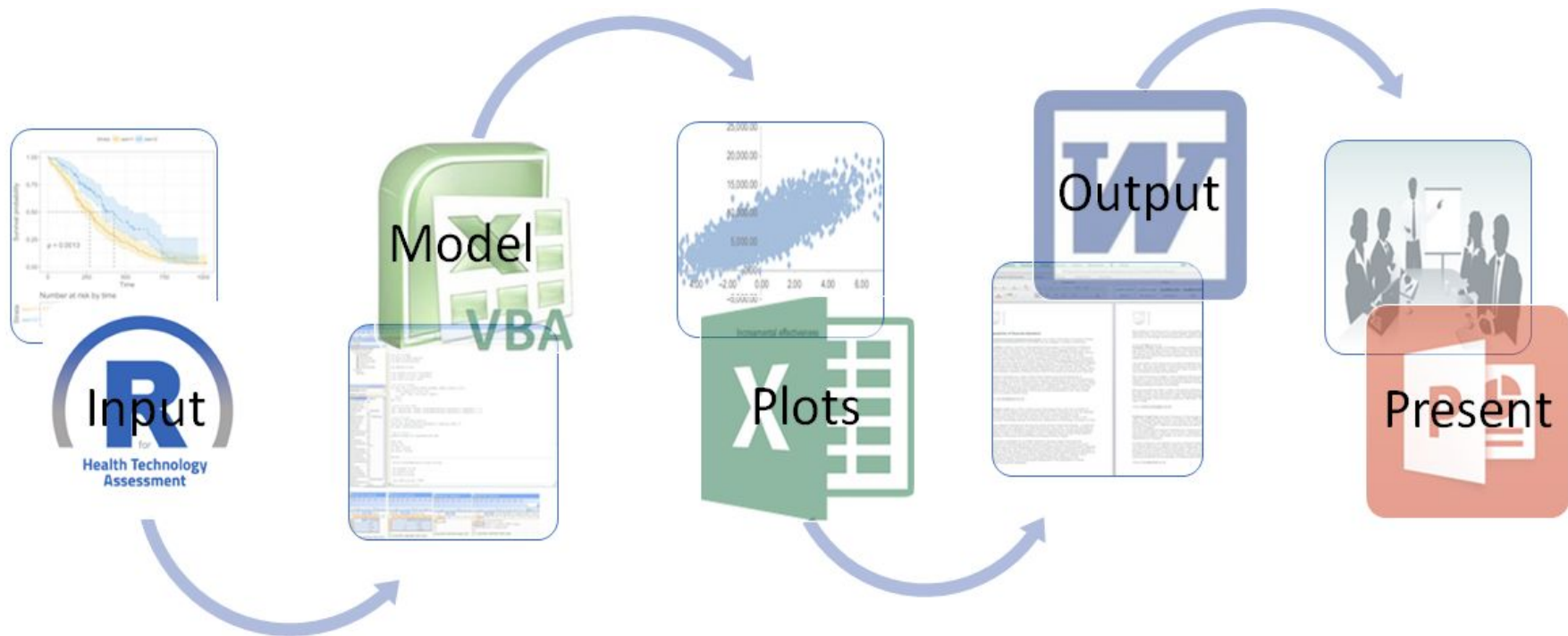
*The **views in this presentation** are those of the author, not of the University of Sheffield or the UK Health Security Agency.*

Grant information:

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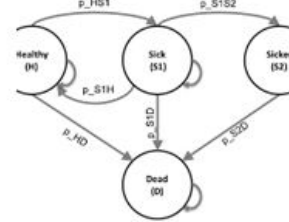
Current Process

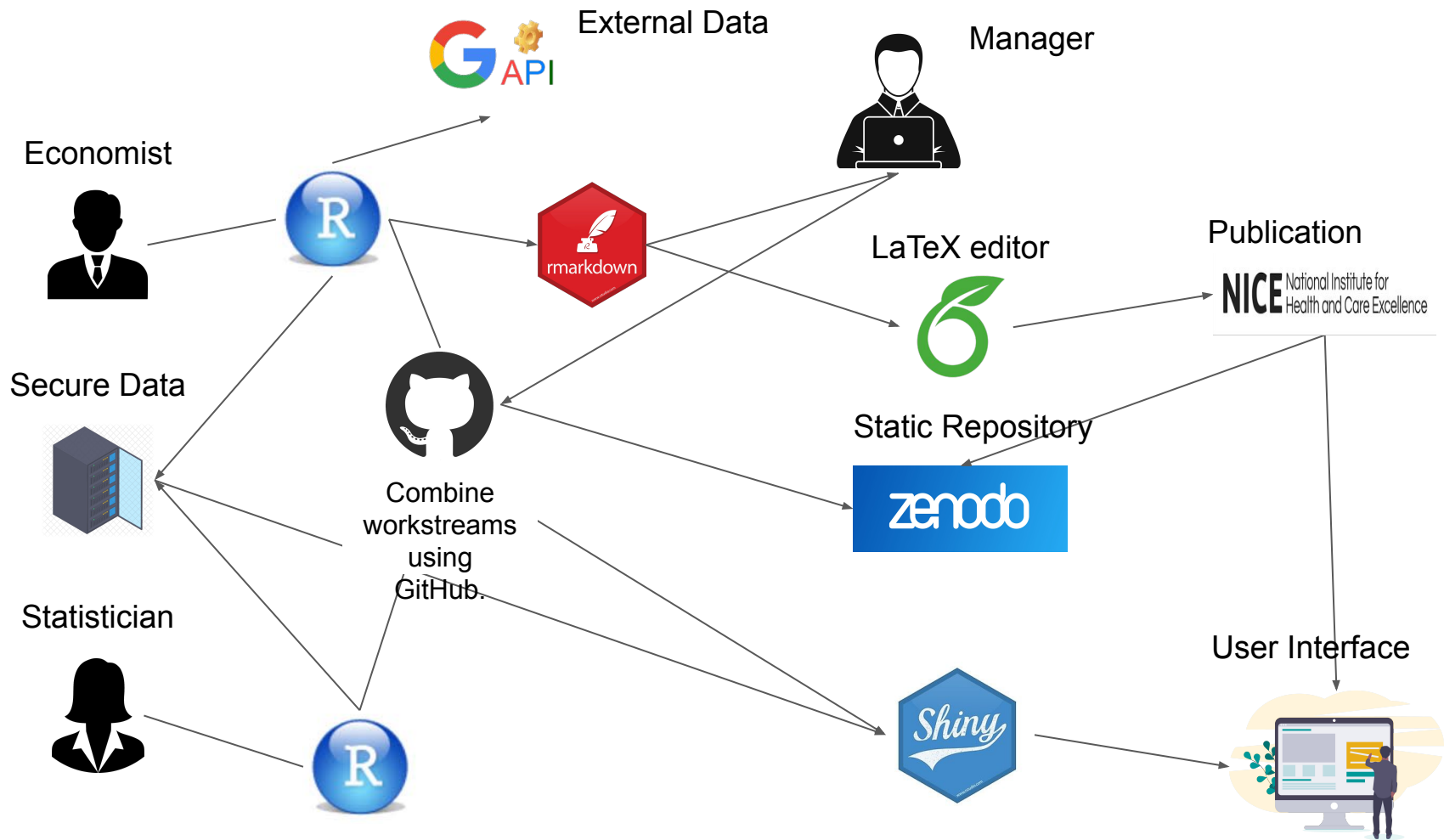




1. 274 284 294 304 314 324 334 344 354 364 374 384 394 404 414 424 434 444 454 464 474 484 494 504 514 524 534 544 554 564 574 584 594 604 614 624 634 644 654 664 674 684 694 704 714 724 734 744 754 764 774 784 794 804 814 824 834 844 854 864 874 884 894 904 914 924 934 944 954 964 974 984 994

nonetheless and average findings for medical innovations and the UK are compared with those for the US. The authors conclude that the UK is more likely to be a barrier to innovation (as determined by statistical analysis) than the US, but that this is due to differences affecting only local constraints on medical spending by the UK, not to differences in the UK's overall innovation environment. The authors also call for the UK to reorganise their NHS services in alignment with the efficient use of resources and to encourage the UK's private sector to invest in the development of new medical innovations. Nevertheless, the current pattern of health technology innovation in the UK is far from ideal. The authors conclude that the UK is not doing well in maintaining NHS's current approach to HTA, the UK risks suboptimal adoption of new medical technologies, and the UK may lose out if it does not improve its current position with generic drugs. The authors conclude that the UK is not doing well in maintaining NHS's current approach to HTA, the UK risks suboptimal adoption of new medical technologies, and the UK may lose out if it does not improve its current position with generic drugs.







Future Process: Benefits

1. One click update + transcription error reduction.
2. Speed of model creation (hence R not C++, time is money)!
3. Computational power (Rcpp) - VOI, analysis.
4. Code/data separation, testing independent of data.
5. Transparency - especially where publicly funded.
6. Reach & replication, one worldwide model on remote server.
7. Stakeholder engagement - Shiny + expert elicitation.



Graphical User Interface



Monthly Auto Sales Report							
	January	February	March	QTR 1	April	May	June
Sheila W.	166,000	182,000	204,600		182,500	174,500	
Mark T.	152,000	177,000	158,000		183,750	201,000	
Shane S.	174,500	162,000	189,750		177,000	168,750	
John K.	201,000	199,000	182,500		162,000	182,000	
Bob M.	168,750	173,250	183,750		166,000	177,000	
Totals			=SUM(D5:D9)				
Average Monthly Totals							
Largest Monthly Sales							
Minimum Monthly Sales							

```
120 i.state<-ID=1811
121 i.state<-ID=i.state-cost_ID/10
122 event_costs[i,]<-round(sample,n
123
124 colnames(event_costs)<-event_names
125
126 # probability pattern will switch
127 event_switch_prob=matrix(0,nrow
128 colnames(event_switch_prob)<-event
129 # only switch after 10 if on final
130 event_switch_prob[,10]<-rep(1/7
131 id.disc.parameter<-list("alpha"<-0.1,
132 event_switch_prob[,10]<-rep(1/7
133 b.disc.parameter<-list("alpha"<-0.5,
134 event_switch_prob[,10]<-rep(1/7
135 tla.disc.parameter<-list("alpha"<-0.1,
136 event_switch_prob[,10]<-rep(1/7
137 as.disc.parameter<-list("alpha"<-0.1,
138 event_switch_prob[,10]<-rep(1/7
139 event_switch_prob[,10]<-rep(1/7
140 event_switch_prob[,10]<-rep(1/7
141 event_switch_prob[,10]<-rep(1/7
142
143 # hazard ratios for effect of prior
144 hr.event.history<-array(1,dimension
145 # effect of prior history on future
146 hr.event.history.event_state.code
147 hr.event.history.event_state.code
148 # had to assume effect on death
149 hr.event.history.event_state.code
150 hr.event.history.event_state.code
151 hr.event.history.event_state.code
152 hr.event.history.event_state.code
153 hr.event.history.event_state.code
154 # effect of prior history on future
155 hr.event.history.event_state.code
156 hr.event.history.event_state.code
157 # had to assume effect on death
158 hr.event.history.event_state.code
159 hr.event.history.event_state.code
160 hr.event.history.event_state.code
161 hr.event.history.event_state.code
162 hr.event.history.event_state.code
163 # effect of prior history on future
164 hr.event.history.event_state.code
165 hr.event.history.event_state.code
166
```

```
11 # Labrines version
12 next_state_name<-function(old.state.name,event.code)
13 {
14   # Extract the number, health state
15   i.health.state<-n.health.state
16   while(substr(old.state.name,nchar(old.state.name)-n
17     # Extract the treatment name
18     treatment_name<-substr(old.state.name,5),nchar(old.st
19     # Extract the old health state
20     health.state<-nondeath.health.state[i.health.state]
21     if(event.code=="D")
22     {
23       if(health.state=="Dell")
24         return(paste(treatment.name," D ",sep=""))
25       if(health.state=="S")
26         return(paste(treatment.name," S ",sep=""))
27       if(health.state=="I")
28         return(paste(treatment.name," I ",sep=""))
29       if(health.state=="N")
30         return(paste(treatment.name," N ",sep=""))
31       if(health.state=="M")
32         return(paste(treatment.name," M ",sep=""))
33     }
34     return(paste(treatment.name," D + M ",sep=""))
35   }
36
```

Platform: x86_64-w64-mingw32/x64 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.

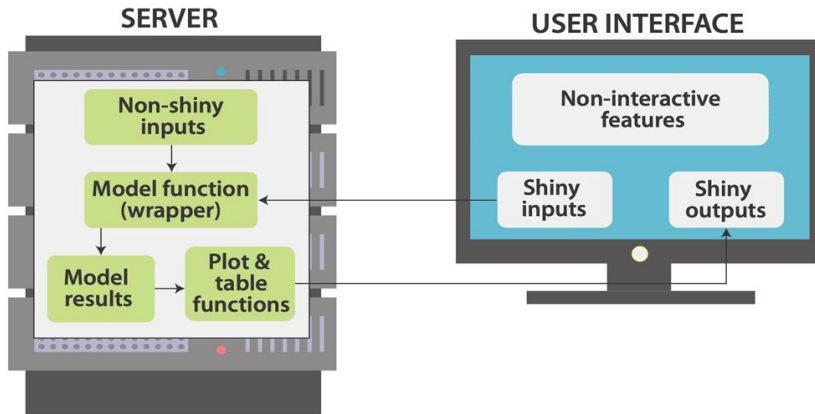
Type 'q()' to quit R.

“... that code looks scary” (Anon, 2020)

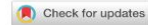


Open-source tutorial

ShinyApp function



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METHOD ARTICLE

REVISED Making health economic models Shiny: A tutorial [version 2; peer review: 2 approved]

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* Equal contributors

[✉ Author details](#)

Abstract

Health economic evaluation models have traditionally been built in Microsoft Excel, but more sophisticated tools are increasingly being used as model complexity and computational requirements increase. Of all the programming languages, R is most popular amongst health economists because it has a plethora of user created packages and is highly flexible. However, even with an integrated development environment such as R Studio, R lacks a simple point and click user interface and therefore requires some programming ability. This might make the switch from Microsoft Excel to R seem daunting, and it might make it difficult to directly communicate results with decisions makers and other stakeholders.

The R package Shiny has the potential to resolve this limitation. It allows programmers to embed health economic models developed in R into interactive web browser based user interfaces. Users can specify their own assumptions about model parameters and run different scenario analyses, which, in the case of regular a Markov model, can be computed within seconds. This paper provides a tutorial on how to wrap a health economic model built in R into a Shiny application. We use a four-state Markov model developed by the Decision Analysis in R for Technologies in Health (DARTH) group as a case-study to demonstrate main principles and basic functionality.

A more extensive tutorial, all code, and data are provided in a [GitHub repository](#).

Keywords

Health Economics, R, RShiny, Decision Science

ALL METRICS

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Paper: <https://wellcomeopenresearch.org/articles/5-69>
Code: https://github.com/RobertASmith/healthecon_shiny



Simple app

Sick Sicker Model in Shiny

Treatment Cost

200

PSA runs

1000

initial age

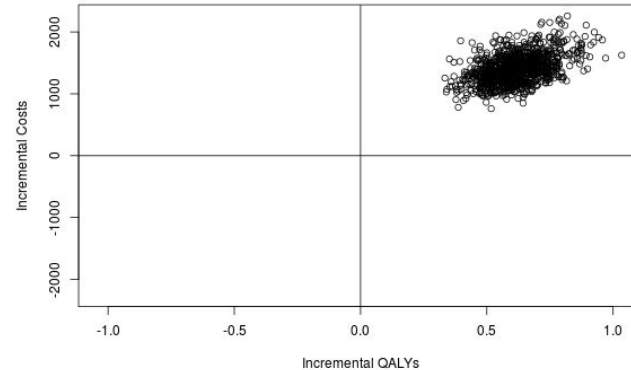
10 25 80

Run / update model

Results Table

Option	QALYs	Costs	Inc.QALYs	Inc.Costs	ICER
Treatment	18.59	100441.67	0.62	1406.24	2324.54
No Treatment	17.97	99035.43	NA	NA	NA

Cost-effectiveness Plane



https://robertasmith.shinyapps.io/sick_sicker



Open-source tutorial

Inputs \longrightarrow Function \longrightarrow Outputs

Parameters		
c_s1	cost1	3
c_s2	cost2	5
c_H	cost3	6
dr	Dis_rate	0.035
n_sim	No. psa	1000

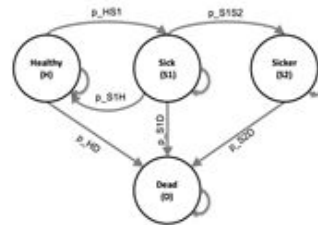
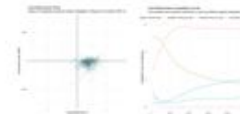


Figure 1: State-transition diagram of the true-independent Sick-Sicker cohort state-transition model with the name of the health state and possible transitions with their corresponding transition probabilities.

Results Table

Option	QALYs	Costs	Inc. QALYs	Inc. Costs	ICER
Treatment	18.56	101106.37	0.63	1422.23	2320.60
No Treatment	17.93	99684.14	N/A	N/A	N/A

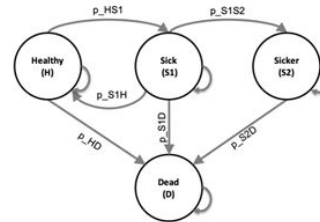




Open-source tutorial

Inputs \longrightarrow Function \longrightarrow Outputs

Parameters		
c_s1	cost1	3
c_s2	cost2	5
c_H	cost3	6
dr	Dis_rate	0.035
n_sim	No. psa	1000



Results Table

Option	QALYs	Costs	Inc.QALYs	Inc.Costs	ICER
Treatment	18.56	101106.37	0.63	1422.23	2320.60
No Treatment	17.93	99684.14	N/A	N/A	N/A

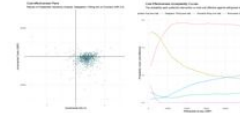


Figure 1: State-transition diagram of the time-independent Sick-Sicker cohort state-transition model with the name of the health states and possible transitions with their corresponding transition probabilities.



Treatment Cost

PSA runs

Initial age



UI code

```
ui <- fluidPage (    # creates empty page
```

```
# title of app
```

```
titlePanel("Sick Sicker Model in Shiny"),
```

```
# layout is a sidebar-layout
```

```
sidebarLayout(
```

```
# open sidebar panel
```

```
< SIDEBAR PANEL CODE >
```

```
# open main panel
```

```
< MAIN PANEL CODE >
```

```
) # close sidebarlayout
```

```
) # close UI fluidpage
```

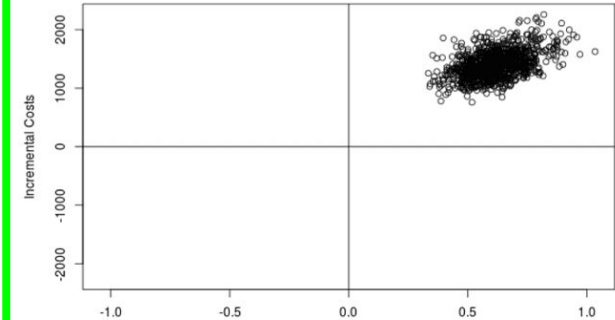
Sick Sicker Model in Shiny

The image shows the user interface of a Shiny application. It has a sidebar on the left with three input controls: a "Treatment Cost" dropdown menu set to 200, a "PSA runs" text input field set to 1000, and an "initial age" slider set to 25. Below these inputs is a "Run / update model" button. The main panel on the right is currently empty.

Results Table

Option	QALYs	Costs	Inc.QALYs	Inc.Costs	ICER
Treatment	18.59	100441.67	0.62	1406.24	2324.54
No Treatment	17.97	99035.43	NA	NA	NA

Cost-effectiveness Plane





Sidebar Panel Code



```
sidebarPanel( # open sidebar panel

  numericInput(inputId = "SI_c_Trt",
    label = "Treatment Cost",
    value = 200,
    min = 0,
    max = 400),

  numericInput(inputId = "SI_n_sim",
    label = "PSA runs",
    value = 1000,
    min = 0,
    max = 400),

  sliderInput(inputId = "SI_n_age_init",
    label = "Initial Age",
    value = 25,
    min = 10,
    max = 80),

  # action button runs model when pressed
  actionButton(inputId = "run_model",
    label = "Run model")

) # close sidebarPanel
```

The screenshot shows a sidebar panel with three input controls and an action button. The first control is a text input labeled "Treatment Cost" with a value of 200. The second is another text input labeled "PSA runs" with a value of 1000. The third is a slider input labeled "initial age" with a range from 10 to 80 and a current value of 25. Below these inputs is a button labeled "Run / update model".



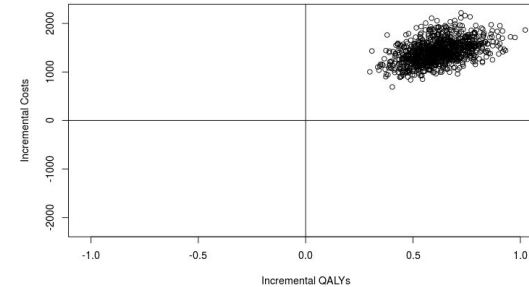
Main Panel Code

```
mainPanel(  
  
# heading (results table)  
  h3("Results Table"),  
  
# tableOutput id = icer_table, from server  
  tableOutput(outputId = "SO_icer_table"),  
  
# heading (Cost effectiveness plane)  
  h3("Cost-effectiveness Plane"),  
  
# plotOutput id = SO_CE_plane, from server  
  plotOutput(outputId = "SO_CE_plane")  
  
) # close mainpanel
```

Results Table

Option	QALYs	Costs	Inc.QALYs	Inc.Costs	ICER
Treatment	18.61	101016.42	0.62	1412.82	2335.56
No Treatment	17.99	99603.60	NA	NA	NA

Cost-effectiveness Plane





Server Code

```
server <- function(input, output){

  observeEvent(input$run_model, # WHEN ACTION BUTTON PRESSED
    ignoreNULL = F, {

    # Run model function with Shiny inputs
    df_model_res = f_wrapper(c_Trt = input$SI_c_Trt,
                             n_age_init = input$SI_n_age_init,
                             n_sim = input$SI_n_sim)

    #— CREATE COST EFFECTIVENESS TABLE —#
    # renderTable continuously updates table
    output$SO_icer_table <- renderTable({ < ICER TABLE FUNCTION > }) # table plot end.

    #— CREATE COST EFFECTIVENESS PLANE —#
    # render plot repeatedly updates.
    output$SO_CE_plane <- renderPlot({ < CE PLANE FUNCTION > }) # renderplot end

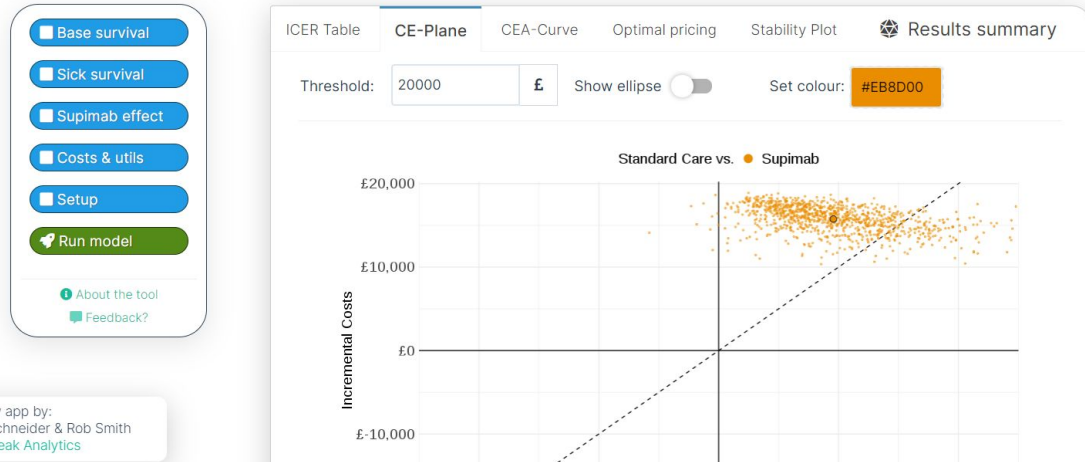
  }) # Observe event end

} # Server end
```



More sophisticated app

A lean shiny app for a simple markov model - [beta 1.0](#)



A shiny app by:
Paul Schneider & Rob Smith
[Dark Peak Analytics](#)

<https://darkpeakanalytics.shinyapps.io/sadm-mk2/>



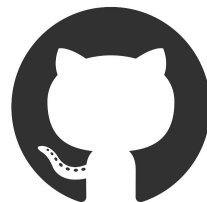
Open-source materials

Simple materials:

App: https://robertasmith.shinyapps.io/sick_sicker/
Paper: <https://wellcomeopenresearch.org/articles/5-69>
Code: https://github.com/RobertASmith/paper_makeHEshiny
Tutorial: https://r-hta.org/tutorial/markov_models_shiny/

More advanced materials:

App: <https://darkpeakanalytics.shinyapps.io/sadm-mk2/>
Code: <https://github.com/bitowaqr/sadm-mk2>
Package: <https://github.com/RobertASmith/darkpeak>





Thanks from Sheffield

Git: <https://github.com/RobertASmith>
Web: <https://www.darkpeakanalytics.com/>
Email: rasmith3@sheffield.ac.uk
LinkedIn: <https://www.linkedin.com/in/robert-smith-53b28438/>